

AFC Economic Case Study

E. D. Collins, ORNL

J. J. Laidler, ANL

W. B. Boore, WSRC

J. D. Smith, SNL

Presented at
AFCI Semi-Annual Meeting
Albuquerque, New Mexico
January 22, 2003



Assumptions

Time Period

Nuclear Power Generation

Next 40 years

Constant 100 GWe

Cases Evaluated

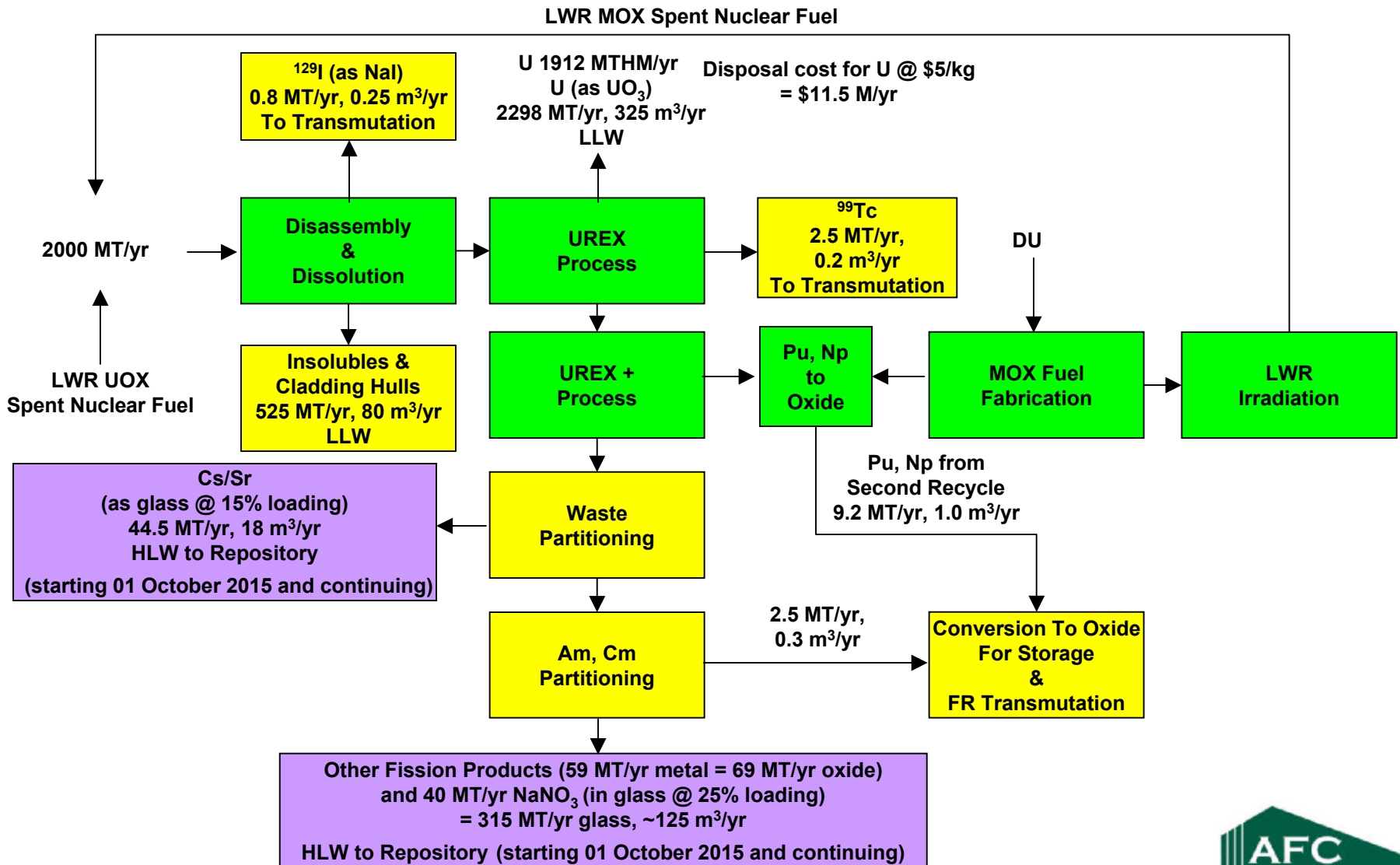
- Case 0** **Current Once-Through LWR Spent Fuel Disposal**
- Case 1** **Chemical Processing of LWR Spent Fuel (2000 MT/Year)**
- Case 2** **Chemical Processing of LWR Spent Fuel (2000 MT/Year) and
LWR MOX Fuel Fabrication/Irradiation (2 cycles)**
- Case 3** **Chemical Processing of LWR Spent Fuel (2000 MT/Year) and
HTGR Pu-Np Fuel Fabrication/Irradiation (1 cycle)**

Summary of Cost Savings for Cases 1-3

	Case 0	Case 1	Case 2	Case 3
	\$M	\$M	\$M	&M
Comparative Cost of Repository	35000	35000	35000	35000
Scenario Net Cost	-35000	-20600	-12032	-14887
<i>Difference (Cost Savings)</i>	<i>0</i>	<i>14400</i>	<i>22968</i>	<i>20113</i>

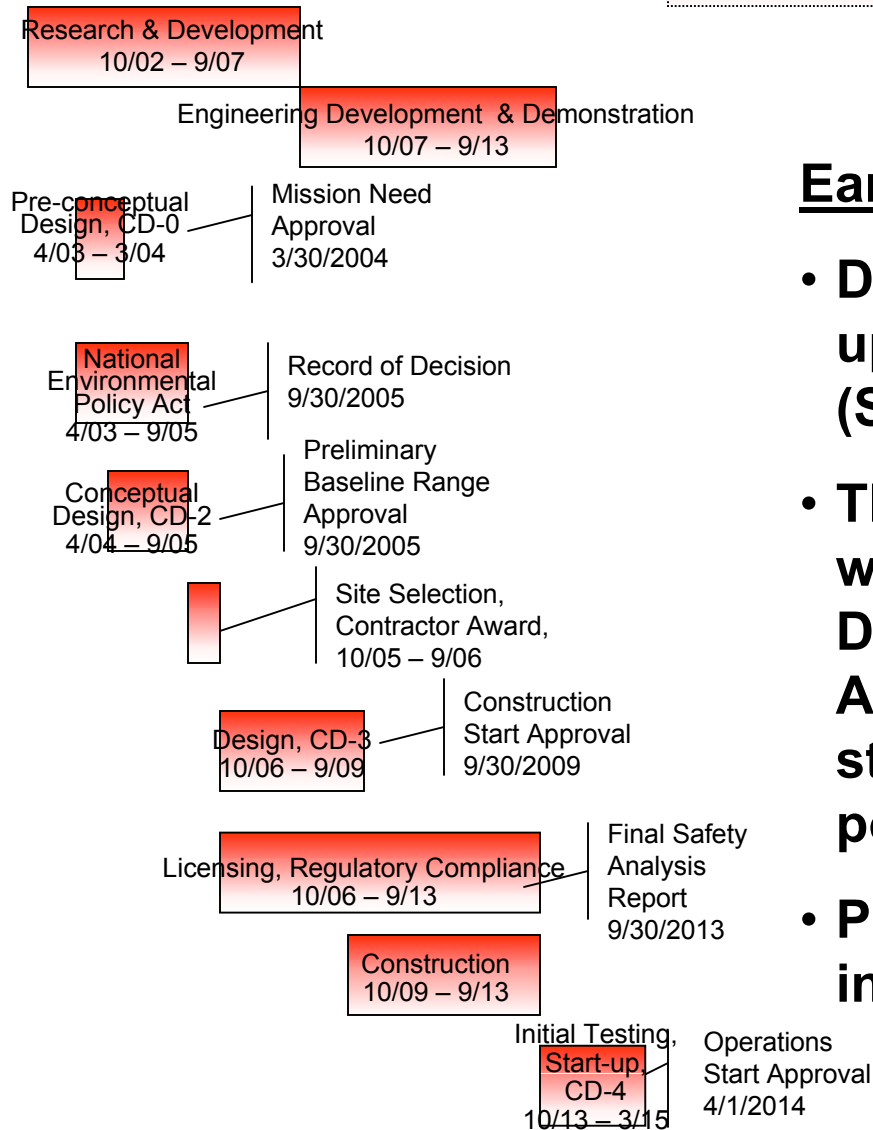


Case 2: Process Material Mass Flow



Case 2

Chemical Processing and LWR MOX Fuel Fabrication Plants

Early Start is Necessary

- **Design, construction, and start-up requires minimum of 8 years (Sept 2006—April 2015)**
- **The schedule is very tight, even within the next 3–4 years. Decisions must be made quickly. Actions to initiate the required steps are needed as soon as possible**
- **Project capital funding must be initiated by FY 2007**

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (y)	Estimated Cost		Basis
			\$M/y	\$M	
Research & Development	10/02 - 9/07	5	9	46	FY 03 through FY 07; \$6, 7, 11, 11, 11M FY 08 through FY 15; \$30,40,45,45,45,45,40,30M
Engineering Development & Demonstration	10/07 - 9/13	8	40	320	
Preconceptual Design, CD-0 Mission Need Approval	4/03 - 3/04 3/30/2004	1	6	6	30 man-years; FY 03-FY 04
NEPA Actions Record of Decision	4/03 - 9/05 9/30/2005	2	3	6	30 man-years; FY 03-FY 05
Conceptual Design, CD-1 Preliminary Baseline Range Approval	4/04 - 9/05 9/30/2005	2	12	24	120 man-years; FY 04-FY 05
Site Selection, Contractor Award	10/05 - 9/06	1			
Licensing, Regulatory Compliance Final Safety Analysis Report Preliminary Design, CD-2, Final Design, & CD-3	10/06 - 9/13 9/30/2013 10/06 - 9/09	7 3	2 476	14 1400	1400 man-years; FY 07-FY 09; using PNNL cost estimating procedure for the ATW Roadmap, the design cost would be \$430M
Construction Start Approval Construction	9/30/2009 10/09 - 9/13	4	1850	7400	Same basis as Case 1 except with integral design, construction, and licensing of chemical processing and MOX fuel fabrication plants within the same plant site with common physical safeguards protection, common utility services, laboratory facilities, etc.
Operations Start Approval Initial Testing, Startup, CD-4	4/1/2014 10/13 - 3/15	1.5	425	635	Based on 120% of estimated operations & maintenance costs
Other Project Costs (OPC)	4/03 - 3/15	12	218	2616	OPC (less ED&D, Conceptual Design, Licensing, NEPA and Start-up). Based upon the total OPC being ~40% of the TEC (Design + Construction).
Operations & Maintenance	4/15 - 9/45	30	353	10590	Based on cost of MOX fuel at \$2000/kg fabricated fuel
Incoming Transportation of Spent Fuel	3/15 - 9/44	30	17	510	170 shipments per year at \$100K each
Outgoing transportation of MOX fuel to reactors	10/15 - 9/45	30	2	45	30 shipments per year at \$50K each
Outgoing Transportation of HLW to Repository	10/15 - 9/45	30	2	60	20 shipments per year (5 logs each) at \$100K per shipment
Outgoing Disposal of LLW	10/15 - 9/45	30	12	360	Uranium at \$11.5M/y; other LLW at \$0.5M/y.
Total Costs for Case 2		30	801	24032	
Fuel replacement credit		30	-400	-12000	Replaces 400 t/y UOX fuel at \$1000/kg
Net Costs for Case 2		30	401	12032	
Comparative Costs of Repository		30	1167	35000	Includes costs of design, construction, licensing, and operation
Difference (Cost Savings)		30	766	22968	



Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (Y)	Estimated Cost	
			\$M/y	\$M
Research & Development	10/02 - 9/07	5	9	48
Engineering Development & Demonstration	10/07 – 9/13	8	40	320

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (Y)	Estimated Cost	
			\$M/y	\$M
Preconceptual Design, CD-0	4/03 – 3/04	1	6	6
Mission Need Approval	3/30/2004			
NEPA Actions	4/03 – 9/05	2	3	6
Record of Decision	9/30/2005			
Conceptual Design, CD 1	4/04 – 9/05	2	12	24
Preliminary Baseline Range Approval	9/30/2005			

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (Y)	Estimated Cost	
			\$M/y	\$M
Site Selection, Contractor Award	10/05 – 9/06	1		

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (Y)	Estimated Cost	
			\$M/y	\$M
Licensing, Regulatory Compliance	10/06 – 9/13	7	2	14
Final Safety Analysis Report	9/30/2013			
Preliminary Design, CD-2, Final Design, & CD-3	10/06 – 9/09	3	476	1400
Construction Start Approval	9/30/2009			
Construction	10/09 – 9/13	4	1850	7400
Operations Start Approval	4/1/2014			
Initial Testing, Startup, CD-4	10/13 – 3/15	1.5	425	635
Other Project Costs (OPC)	4/03 – 3/15	12	218	2616

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Time Period	Duration (Y)	Estimated Cost	
			\$M/y	\$M
Operations & Maintenance	4/15 – 9/45	30	353	10590
Incoming Transportation of Spent Fuel	3/15 – 9/44	30	17	510
Outgoing transportation of MOX fuel to reactors	10/15 – 9/45	30	2	45
Outgoing transportation of HLW to Repository	10/15 – 9/45	30	2	60
Outgoing disposal of LLW	10/15 – 9/45	30	12	360

Case 2. Chemical Processing and LWR MOX Fuel Fabrication Plants

Activity	Duration (Y)	Estimated Cost	
		\$M/y	\$M
Total Costs for Case 2	30	801	24032
Fuel Replacement Credit	30	-400	-12000
Net Costs for Case 2	30	401	12032
Comparative Costs of Repository	30	1167	35000
Difference (Cost Savings)	30	766	22968

Opportunities for Cost Reduction and Repository Benefits

Costs can be minimized by:

- **Using co-located chemical processing, fuel fabrication, and waste storage to enable shared attributes and minimize transportation**
- **Minimizing the number of process steps and simplifying the process steps needed**
- **Maximizing the use of automated processes and robotic techniques**
- **Providing for more flexible use of Yucca Mountain with likely reduced cost per unit placement**

Simultaneous repository benefits can be improved by:

- **Reprocessing spent fuels to enable HLW reduction (uranium and cladding removal)**
- **Encapsulation of HLW in better waste forms having improved long-term containment and more cost-efficient packaging**
- **Separate placement of heat generating fission products (^{137}Cs and ^{90}Sr)**
- **Removing the heat generating long-lived actinides from the HLW**



Conclusions

- Approximately 65% of the expected cost of a 2nd repository can be saved by processing LWR spent fuel, fabricating and irradiating LWR MOX fuel
- Other opportunities exist for further cost reduction
- Substantial capital funding (up to \$12 B) will be required for design and construction during the years 2007–2015
- Tight schedule for completion of this complex facility requires action by the end of 2003 to secure authorization for this project

